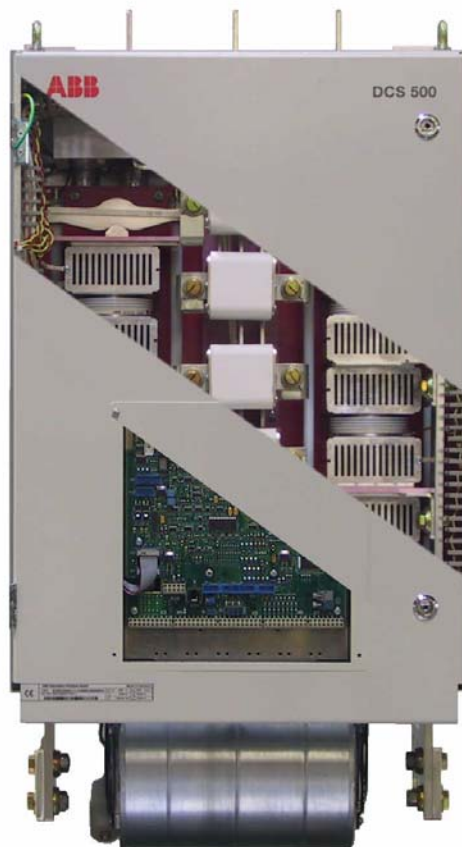


DCS Thyristor Power Converters

for DC drive systems
25 to 5200 A

Technical Data DCS 400
DCS 500B
DCS 600
DCF 500B
DCF 600



ABB

8 Field exciters

The DCS 500 system has different options for the field supply. There are one and three phase field exciters available, which can be either integrated (diode field exciter SDCS-FEX-1 and half controlled field exciter SDCS-FEX-2A) or externally mounted (half controlled DCF503-0050 with the SDCS-FEX-32 board and fully controlled DCF504-0050 with the SDCS-FEX-31 board).

Three phase field exciters DCF 50xB/60x are converter modules themselves, similar to the DCS 501B/601 or DCS 502B/602 additionally a overvoltage protection unit is needed see chapter 8.4.

8.1 SDCS-FEX-1 (internal)

The Diode Field Exciter board SDCS-FEX-1 is a single phase diode rectifier for an AC input voltage up to 500 V and a DC output current of 6 A. The board has to be mounted inside the armature converter module. The excitation current is defined by the DC output voltage (line voltage multiplied by 0.9) and the resistance of the field winding. By using an external resistor in series with the field winding the field current can be adapted slightly. If the SDCS-FEX-1 board isn't already installed it must be mechanically fixed beside the electronic power part SDCS-POW-1 and connected via a flat cable to the SDCS-CON-2 by using terminal X14.

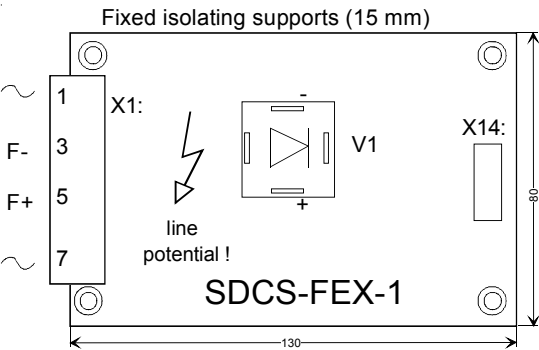


Fig. 8.1/1 Layout of the SDCS-FEX-1 field exciter board

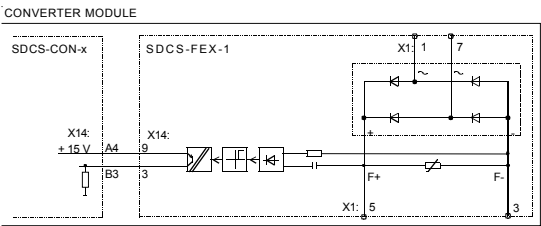


Fig. 8.1/2 Diode field exciter with field loss monitoring

8.1.1 Electrical data of FEX-1

AC input voltage:	110 V -15%...500 V +10%
max. DC output current:	6 A; $I_{F rated}$
DC output curr. monitoring:	20 mA...6 A
Power loss at $I_{F rated}$:	≤ 10 W
AC Isolating voltage:	600 V
Terminals X1:	
Cross sectional area	2,5 mm ²

The AC share of the output DC voltage is measured with a capacitor and an auxiliary rectifier and used for current monitoring. Transistor relay is closed when the DC current is flowing (>0.02 A).

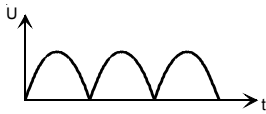


Fig. 8.1/3 Output voltage with inductive or resistive load - **High-signal at X14:B3**

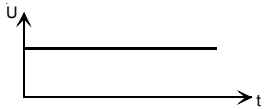


Fig. 8.1/4 Output voltage without load **Low-signal at X14:B3**

8.2 SDCS-FEX-2 / SDCS-FEX-2A (internal)

The field exciter board SDCS-FEX-2 / FEX-2A consists of a power part and a control board, which connects all components electrically and mechanically to each other. This arrangement has to be mounted inside the armature converter module beside the electronic power supply SDCS-POW-1. This is intended to be done for DCS modules of type C1, C2 and A5, not for A6 and A7 (C4)!

The power part is build up with two power modules. Each of the modules consists of one diode and one thyristor, so they are wired up and controlled like a half controlled bridge.

The control is based on a fully digital system. The μ -processor reads all information from the power part, is supplied with all needed voltage levels and control signals via the flat cable X14 by the SDCS-CON-2 and generates the firing pulses for the power part.

The range of the single phase rated AC input voltage is 110 V to 500 V, the maximum current capability is 16 A. If this field exciter is used for smaller field current, the control unit automatically selects a lower current range between 3 A to 16 A to get the best resolution.

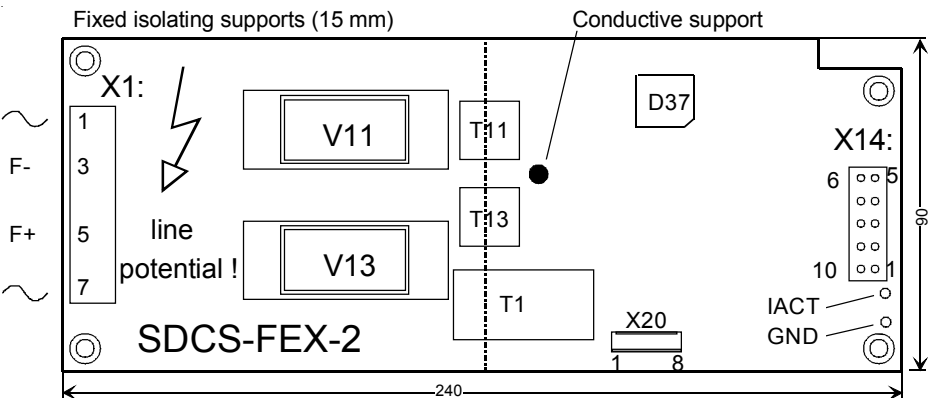


Fig. 8.2/1 Layout of the SDCS-FEX-2A field exciter board

8.2.1 Electrical data of SDCS-FEX-2 / FEX-2A

AC input voltage:	110 V -15%...500 V +10%; single phase
AC input current:	≤ output current
AC isolation voltage:	600 V
Frequency:	same as DCS converter module
DC output current: ①	0.3 A...8 A for armature converter module from 25 A to 75 A 0.3 A...16 A for armature converter mod. from 100 A to 2000 A
Power loss at $I_{F rated}$:	≤40 W
Output IACT:	$U_{out} = 4 V \cdot I_{act} / I_{lim}$; $I_{lim} = 3A, 5A, 7A, 9A, 11A, 13A, 15A, 17A$
Terminal X1:	
Cross sectional area	4 mm²

① If Field weakening is needed, actual field current of the motor at top speed must be higher than 0.3 A

8.2.2 Control unit

The control unit includes the following main blocks:

- Micro controller 80C198 for controlling and firing
- Actual DC current measurement with an AC current transformer.
- RS485 interface to the converter's controller board SDCS-CON-x.

The software for the field current control is stored in the ROM memory of the 80C198. The control is done by using a PI structure for the current controller. All parameters needed for the control or for scaling reasons (selection of burden resistors) are stored in the non-volatile memory of the armature converter and transferred to the field controller during each initializing process via the RS485 link. The Node number is always fix coded to Node number = 1.

The output I_{act} represents the actual field current, which is measured via the AC transformer, then rectified and transferred into a voltage signal with burden resistors. The burden resistors, as mentioned before, are adapted by the board itself depending on the setting of the nominal field current of the motor (see list before). The resulting burden voltage can be measured at test terminals beside X14: The 2.2 K Ω resistor allows a short circuit at the terminals; the external measuring device should have an internal resistance higher than 1 M Ω .

The terminal row X20: is used for test purposes.

8.2.3 Power section

Two diode-thyristor modules are arranged as a half-controlled single-phase rectifier. The anodes of the two diodes are not connected directly to each other as usual; they are now connected to the ends of the four turn primary winding of the current transformer. The center tap is the negative output of the rectifier. Thus it is possible to measure the DC current with an AC current transformer.

A MOV (Metal Oxide Varistor) protects the AC input against voltage spikes from the external source. Another MOV protects the DC output against voltage surges which can be caused by the field winding of a DC machine.

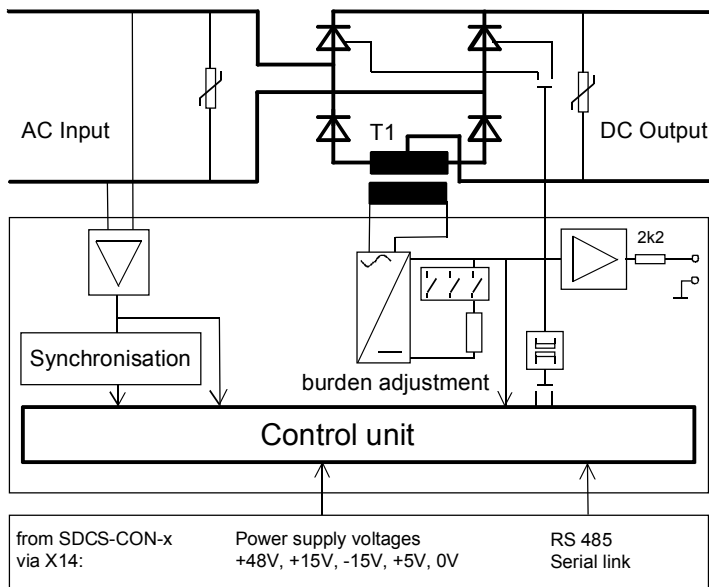


Fig. 8.2/2 Block diagram of the field exciter SDCS-FEX-2A

8.3 DCF503A-0050 and DCF504A-0050 (external)

The **half controlled** (2-Q) field exciter unit DCF503A-0050 consists of the SDCS-FEX-32A board, two thyristor/diode power modules and auxiliaries (power supply, line choke). The **full controlled** (4-Q) field exciter unit DCF504A-0050 consists of the SDCS-FEX-31A board, four anti-parallel thyristor/ thyristor

power modules and the same auxiliaries.

The control is structured similar to the SDCS-FEX-2A field supply. A micro controller is used for controlling and firing. The DC current is measured by using an AC current transformer (same configuration than at SDCS-FEX-2A).

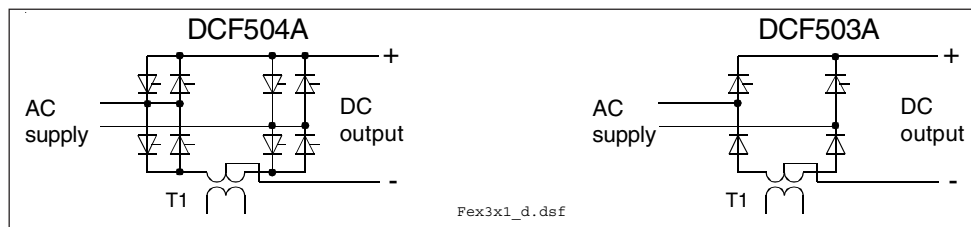


Fig. 8.3/1 Different versions of power section of the DCF50xA-0050

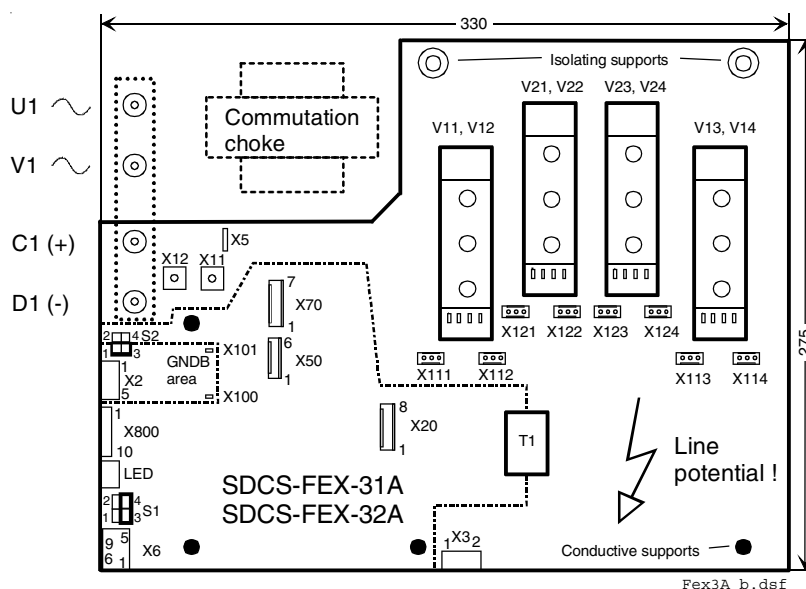


Fig. 8.3/2 Layout of the DCF504A-0050 field exciter unit

Setting X800 Switch	
OFF *	ON
1 Node no. 1 serial link CON-2	Node no. 2 serial link CON-2
2	
3	
4 not used	not used
5	
6	
7	
8 Field exciter mode	Test mode
9 Bridge reversal time: 4 cycles	extended; Bridge reversal time
10 Serial link to CON-1, CON-2	Not used - don't select CON-2

* Default value for all switches
The settings are read during initialization.

Jumper Coding	
Grounding of RS485 Transmission driver	
S2: 1-3 *	GNDB isolated
S2: 1-2	GNDB grounded via RC circuit
S2: 3-4	GNDB direct grounded
CPU mode	
S1: 1-2	Firmware download
S1: 3-4 *	Field exciter mode

* Default value

8.3.1 Electrical data of DCF50xA-0050

Power part	
AC input voltage:	110 V -15%...500 V +10%; single phase
AC input current:	≤ output current
Frequency:	same as DCS converter module
AC isolation voltage:	690 V
Line reactor:	160 μH; 45-65 Hz
DC output current: ①	0.3...50 A
Power loss at $I_{F rated}$:	≤180 W
Load condition	always L/R > 100 ms (saturation)
Auxiliary voltage (X3:1-2)	
AC input voltage:	110 V -15%...230 V +10%; single phase
Frequency:	45 ... 65 Hz
AC input power:	15 W; 30 VA
Inrush current:	<5 A / 20 ms
Mains buffering:	min 30 ms
Terminal row X2:	
X2: 1 RS 485	serial link to X16: 1 at SDCS-CON-1 / CON-2
X2: 2 RS 485	serial link to X16: 2 at SDCS-CON-1 / CON-2
X2: 3 Ground B	grounded via cable screen and / or grounded via S2
X2: 4	not used
X2: 5	not used

① If Field weakening is needed, actual field current of the motor at top speed must be higher than 0.3 A

8.3.2 Electronic power supply

There is a power supply unit on the board. Supply is connected at terminal X3. The rated AC voltages 115 V and 230 V can be applied without any modification.

The power supply unit provides the DC voltages 30 V, 15 V, 5 V and -15 V to the control electronics.

Voltages can be measured by means of a multimeter from the terminal X70 (see the layout).

In addition the power supply generates 5 V for galvanic isolated RS485 communication drivers. This voltages can be measured at terminals X100/X101.

Measured voltage	Terminal positive	Ground
+5V	X70:1	X70:2 (GND)
+30V	X70:3	X70:5 (GND)
+15V	X70:4	X70:5 (GND)
-15V	X70:6	X70:5 (GND)
+ 5V	X100	X101:1 (GNDB)

8.3.3 Control unit

The control unit includes the following main blocks:

- Micro controller H8 for control and firing
- Actual DC current measurement with an AC current transformer.
- RS485 interface to the converter's controller board SDCS-CON-x.

The software for the field current control is stored in the FlashPROM memory. This software contains a PI current controller

Fault/reset logic
Synchronization and PLL function
Bridge reversal function (only DCF 504A)

The setting and updating of all control parameters are set from armature converter via RS485 interface. Actual current, field current reference, control and status bit are cyclic sent via RS 485 communication.

The field exciter is equipped with an auto-scaling function of burden resistor based on the nominal field current of the motor.

The output I_{act} represents the actual field current, which is measured via the AC transformer, then rectified and transferred into a voltage signal with burden resistors. The burden resistors -scaled to measurement range- are adapted by the board itself depending on the setting of the nominal motor field current. The current signal can be measured U_{Cursig} at X20:3-X70:2 and is scaled to

$$4 \text{ V} * I_{act} / I_{Scale}$$

$I_{Scale} = 3A, 5A, 7A, 9A, 11A, 13A, 15A, 17A, 21A, 27A, 33A, 39A, 45A, 51A$

8.3.4 Power section

If a DCF503A-0050 is in use two diode-thyristor modules are arranged as a half-controlled single-phase rectifier. If a DCS504A-0050 is in use four thyristor-thyristor modules are arranged as a full-controlled single-phase rectifier. The anodes of the two diodes (anodes / cathodes of the thyristors) are not connected directly to each other as usual; they are connected to the ends of the primary winding of the current transformer. The centre tap is the negative output of the rectifier. Thus it is possible to measure the DC current with an AC current transformer.

A MOV (Metal Oxide Varistor) protects the AC input against voltage spikes from the external source. Another MOV protects the DC output against voltage surges which can be caused by the field winding of a DC machine. The free wheeling function needed e.g. during network failure is "build in" because of the diodes, if the half-controlled version is in use. If the full-controlled version is used the free wheeling function is realized by using the thyristors in diode mode, triggered by a fast voltage rise.

8.3.5 RS232-Port

The RS232 interface is used for download the 'Field exciter firmware package'.

The default settings of this interface are as follows:

Signal level:	RS232 (+12V / -12V)
Data format:	UART
Message format:	Modbus-Protocol
Transmission method:	half-duplex
Baudrate:	9.600 Baud
Number of Data bits:	8
Number of Stop bits:	1
Parity-Bit:	odd

X6:	Description
1	not connected
2	TxD
3	RxD
4	not connected
5	SGND Signal ground
6...9	not connected

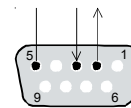


Fig. 8.3/3 Pin assignment of RS232-Port

The programming procedure is activated by setting S1:1-2 during auxiliary voltage is switched ON. Setting for field exciter mode is S1:3-4 (default).

8.3.6 Field exciter configurations

The data exchange between

- SDCS-CON-2 and
- field exciter SDCS-FEX-2A or
- DCF503A/504A-0050 or
- DCFx01/x02 (three-phase field exciter)

is done via a RS485 serial link, which can be configured as a bus structure. This link is used to transfer references, actual values and settings for up to two field exciter units.

The drive software located on the SDCS-CON-2 board consists of two field supply functions, first field exciter and second field exciter. The first field exciter is already connected to the EMF controller to control the motor in all points of the motor diagram. The second field exciter is accessible via the field current reference.

The RS485 interface works with a screened two-wire cable. The allowed length is 5 m. The wires have to be connected to the terminals X2:1 and X2:2 and the screen to X2:3.

Typical application of this kind is two DC motors connected to one converter. The load sharing can be done by means of adjusting the excitation current of the second DC-motor.

There are two possible configurations for two Node numbers of the field exciters:

- one SDCS-FEX-2A and one external field exciter (DCF503A-0050, DCF504A-0050 or 3-phase field exciter) or
- two external field exciter units (DCF503A-0050, DCF504A-0050 or 3-phase field exciter).

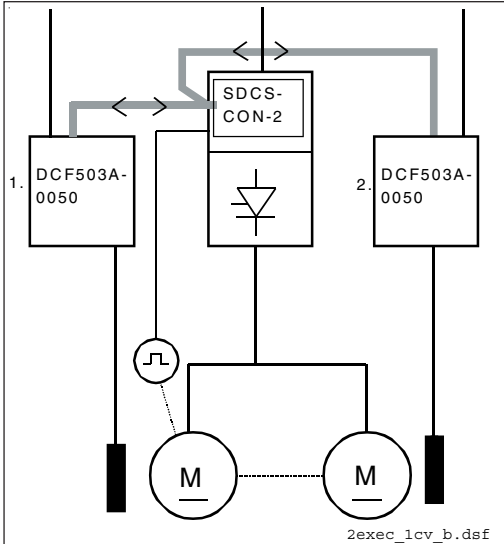


Fig. 8.3/4 Typical application example with two field exciter units and one converter (without field weakening).

If a SDCS-FEX-2A is used, it will be always recognized as the field exciter Node 1 by the software. Node 1 or Node 2 must be coded according to the table below for DCF503A/504A-0050 and for the 3-phase field exciters (via parameter). The scan time for Node 1 = 10 ms, for Node 2 = 100 ms. Field weakening is not necessarily available for Node 2.

Field exciter Node 1		Field exciter Node 2	
Unit type	Setting X800	Unit type	Setting X800
SDCS-FEX-2A	---	---	---
DCF 503A/504A	X800:1 = OFF	---	---
SDCS-FEX-2A	---	DCF 503A/504A	X800:1 = ON
DCF 503A/504A	X800:1 = OFF	DCF 503A/504A	X800:1 = ON

Procedure for field exciter Node changing of the DCF 503A/504A:

- Switch off the units voltage supply
- Set the appropriate switch according to the table
- Initialization through switch on the electronics supply voltage

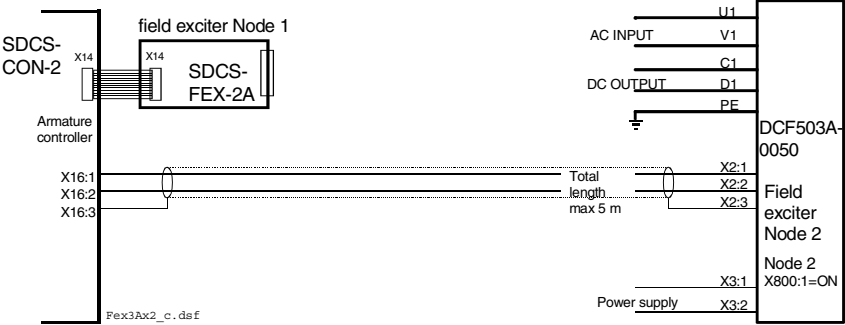


Fig. 8.3/5 Serial communication cable connection and address setting for Node 1 and field exciter Node 2, using SDCS-FEX-2A and DCF50xA-0050

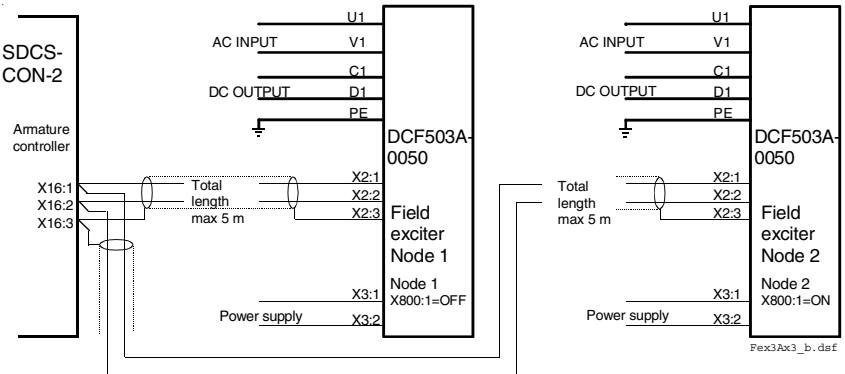


Fig. 8.3/6 Serial communication cable connection